ISMA NAS of Ukraine

Scintillation crystals of rare earth aluminates grown under reducing conditions.

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Outline

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5. Obtaining of YAG:Ce crystals.
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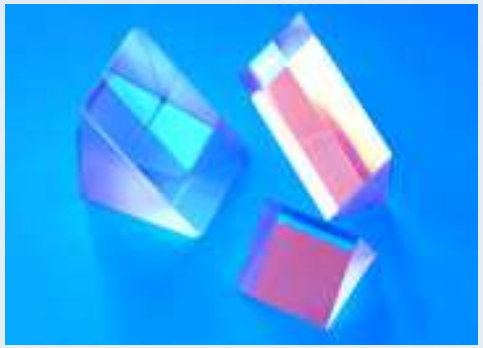
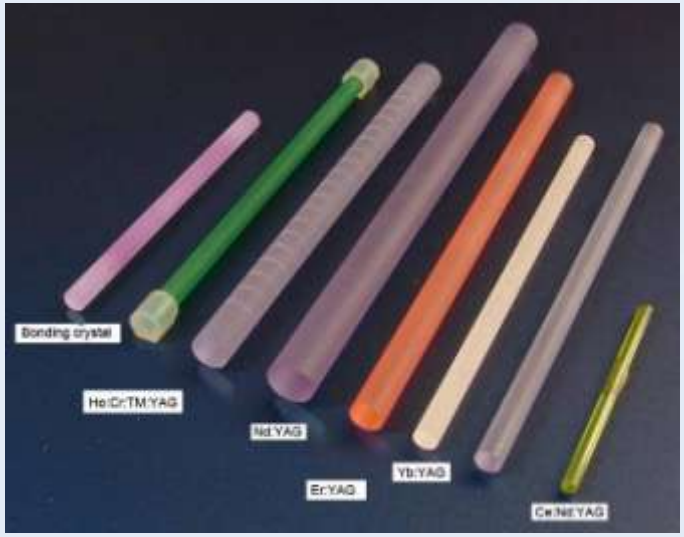
Crystals of rare earth aluminates are widely used in instrumentation.

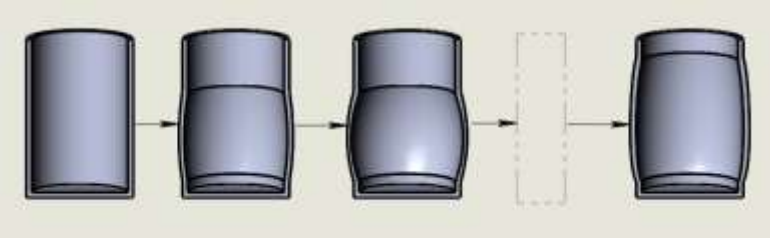
Undoped YAG - as optical element.

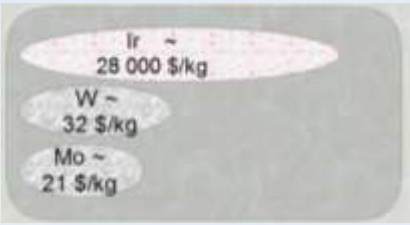


YAG and LuAG activated with rare earth elements are used as laser and scintillation material, YAG:Ce as a phosphor in LED.



Czochralski growth from Ir crucible and its deformation.





Ir replacement – molybdenum (Mo), tungsten (W), and their alloys.

Benefits:

Temperature resistance.
Workability.
Cost – thousand times cheaper.
Durability.

Disadvantages:

More intense oxidation at high temperatures.
Interaction with melt components.

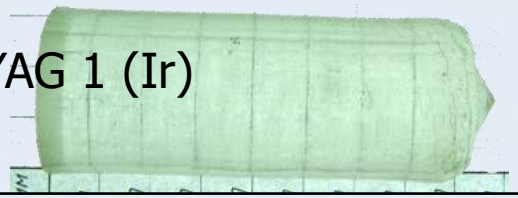
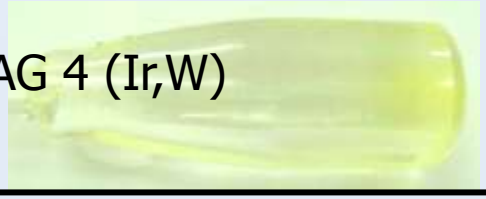
Protective atmosphere:

Carbon monoxide: (CO) **Hydrogen: H2** **Their mix: (CO)+H2**

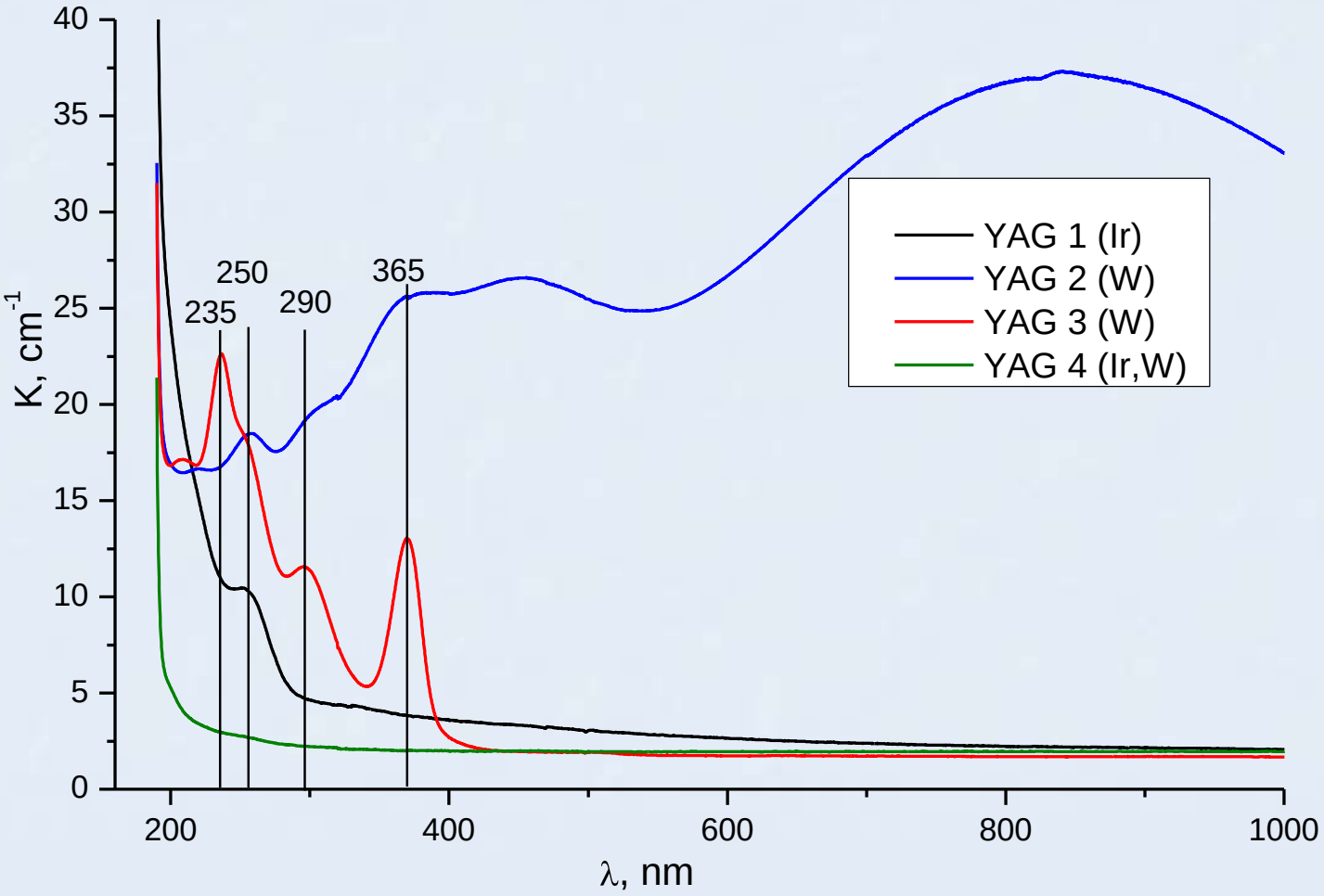
The use of carbon insulation provides a good thermal insulation and a causes the reducing conditions

Ar(>99%) + C +O => Ar + (<1%)CO

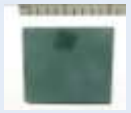
Peculiarities of undoped YAG crystals grown under weak oxidizing and reducing atmosphere.

Raw material, synthesis condition.	Growth conditions	View of as - grown crystals.
Powder of Al_2O_3 & Y_2O_3, sintered under weakly-oxidizing atmosphere under 1600 ^{O}C.	Ir crucible, weakly oxidizing atmosphere.	YAG 1 (Ir) 
Powder of Al_2O_3 & Y_2O_3, sintered under weakly oxidizing atmosphere under 1600 ^{O}C.	W crucible, weakly reducing atmosphere, melt preparation time < 2 h.	YAG 2(W) 
Powder of Al_2O_3 & Y_2O_3, sintered under weakly oxidizing atmosphere under 1600 ^{O}C.	W crucible, weakly reducing atmosphere, melt preparation time < 30 h.	YAG 3 (W) 
YAG 3 crystal.	Ir crucible, weakly oxidizing atmosphere.	YAG 4 (Ir,W) 

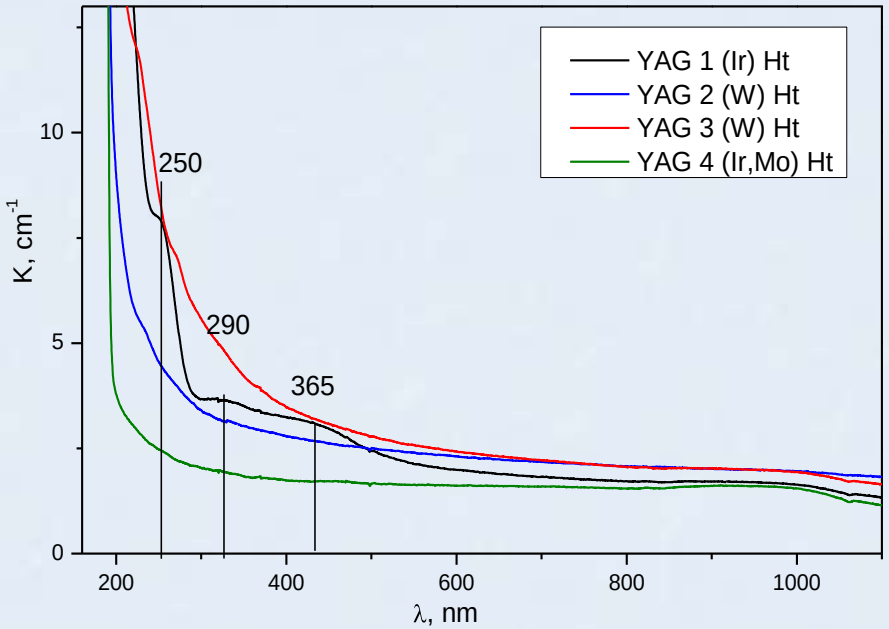
As grown YAG absorption spectra.

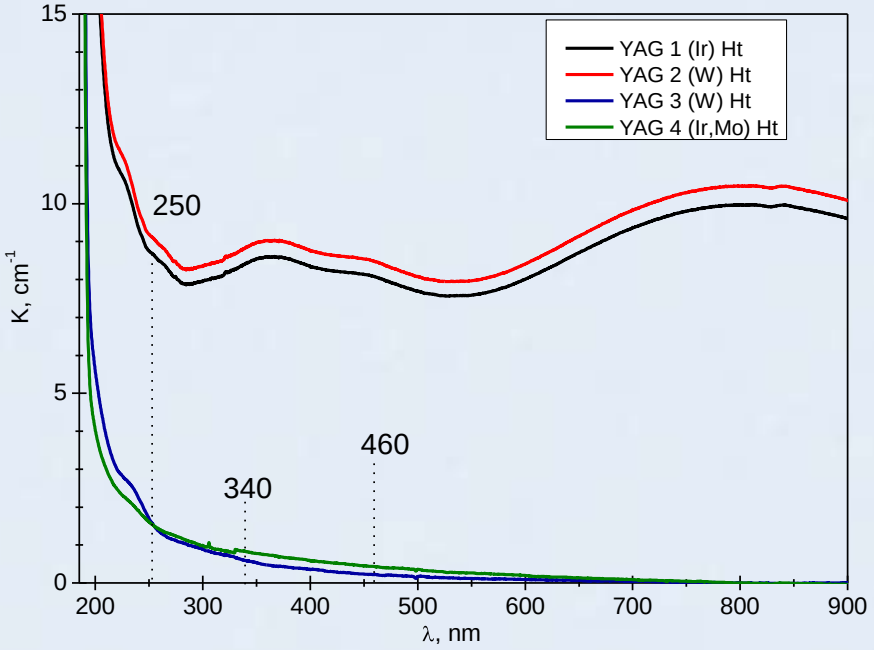


Impact of post growth annealing under oxidizing and reducing atmospheres.

	As- grown	Air 1200 ºC, 5 ч	Ar+CO, 1800 ºC, 30 min
YAG 1 (Ir)			
YAG 2 (W)			
YAG 3 (W)			
YAG 4 (Ir,W)			

Absorption spectra of YAG 1 4 annealed under oxidizing and reducing atmospheres.

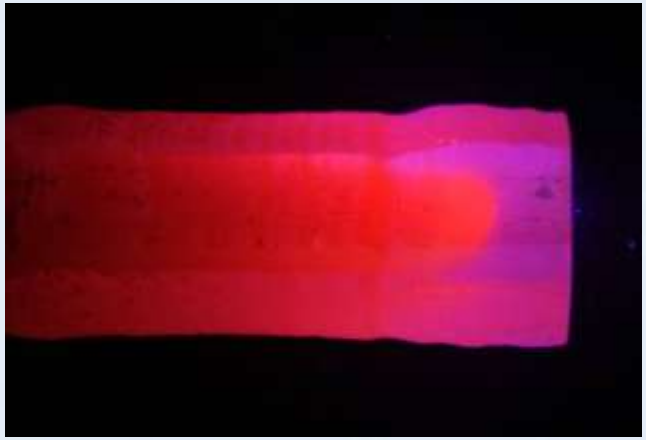




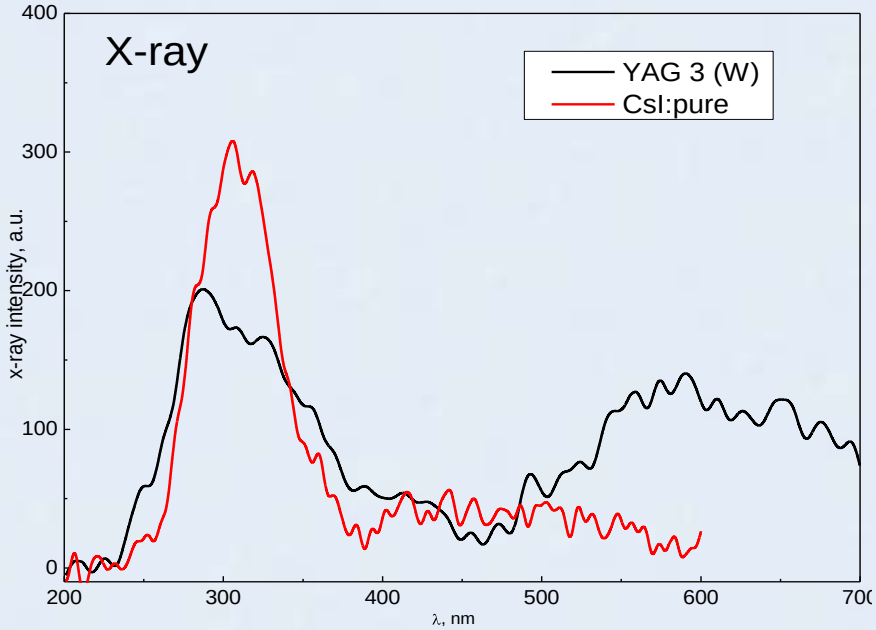
Air treatment 5 h, 1200 C.

Reducing atmosphere treatment 30 min, 1800 C.

X–ray and photoluminescence of YAG(W) crystals.



Photoluminescence of YAG(W) crystals, under 405 nm excitation.



X –ray luminescence of YAG(W) crystals.

Obtaining of undoped LuAG crystals from W crucible under reducing atmosphere.

As-grown LuAG (W) crystal.

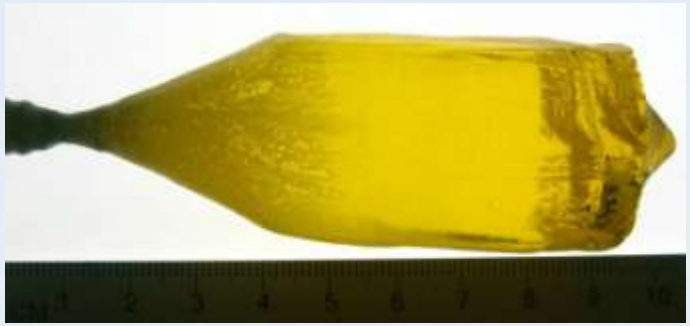
As-grown LuAG (W) sample.

Influence of treatment under reducing atmosphere on coloration of LuAG crystals grown from Ir or W crucible.

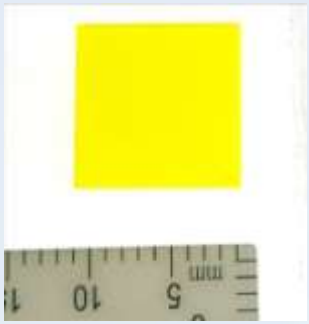
LuAG (Ir) sample Ht CO.

LuAG (W) sample Ht CO.

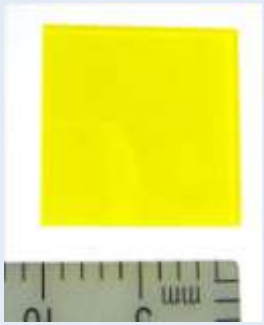
Obtaining of YAG:Ce crystals from W crucible under reducing atmosphere.



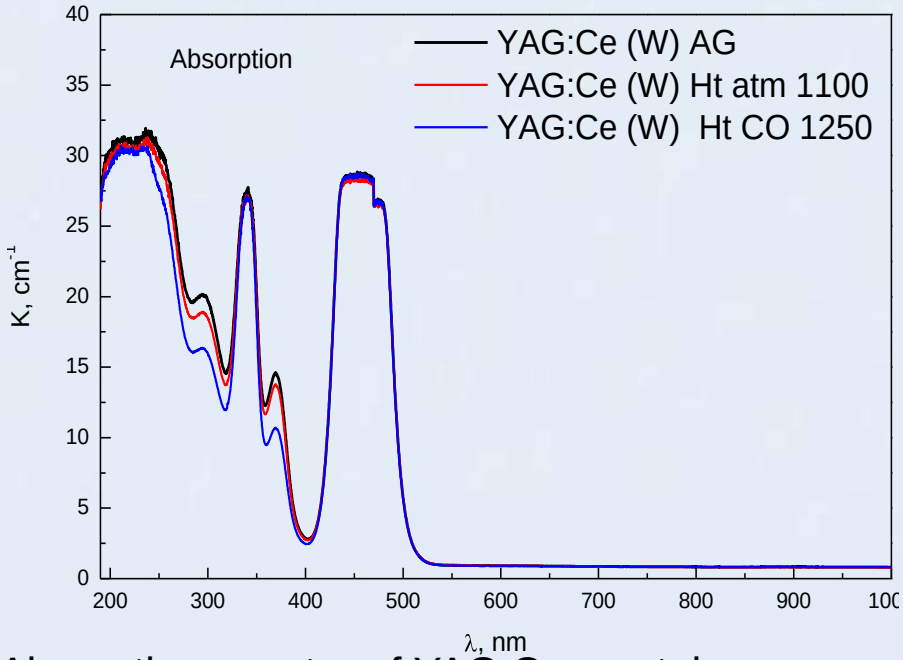
YAG:Ce (W) AG



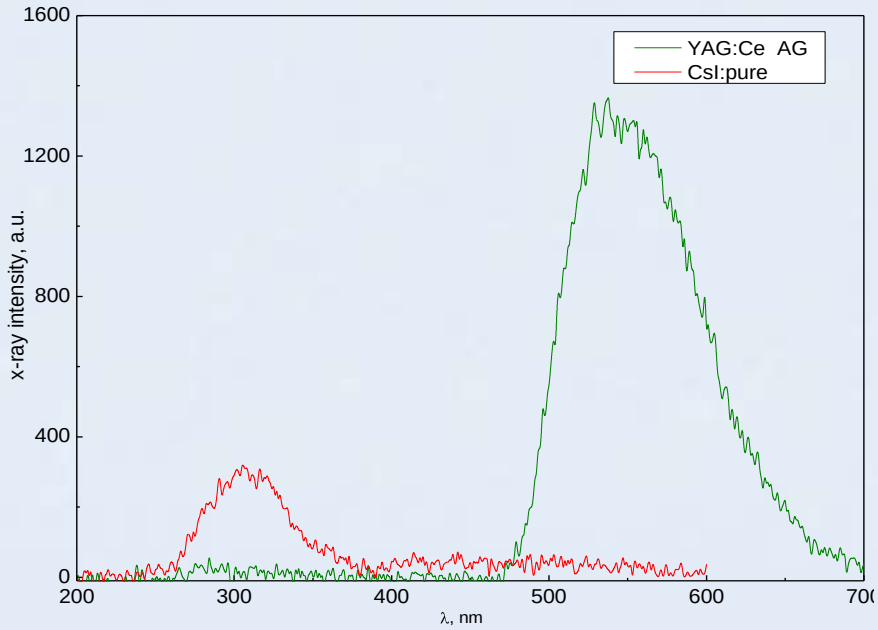
YAG:Ce (W) AG



YAG:Ce (W) Ht CO



Absorption spectra of YAG:Ce crystals, as-grown and treated under oxidative and reducing atmospheres.



X-ray luminescence of as grown YAG:Ce crystals.

Conclusions.

1. Ir crucibles could be replaced by cheaper W crucibles in case of obtaining rare earth aluminates, such as YAG, LuAG, YAG:Ce. Carbon admixture introduces into the crystal, but its position in the lattice is unknown.

2. Post growth thermal treatment is a key factor to obtain optical and scintillation parameters comparable to crystals grown from Ir crucibles.

Acknowledgements

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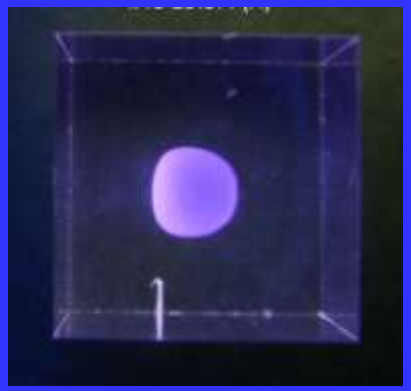
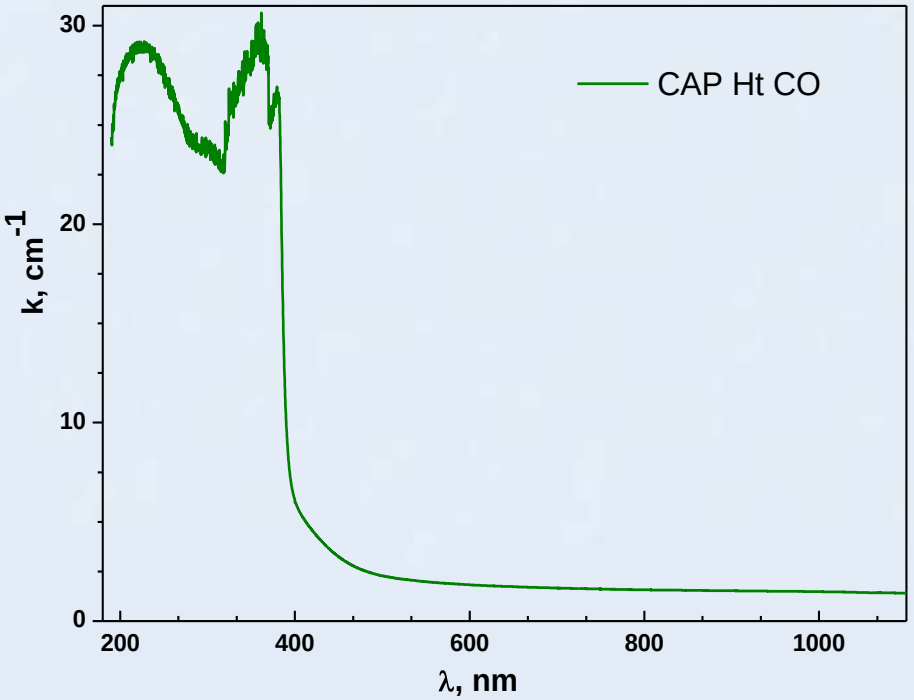
Thank you!



Obtaining of pure $CeAlO_3$ (CAP) crystals from W crucible in reducing atmosphere.

CAP (W) AG

CAP (W) Ht CO



Absorption spectra of CAP (W) crystals treated in CO under 1300 ^{O}C 1 h.